

The NASA SCI Files™  
The Case of the  
Wacky Water Cycle

## Segment 2

The tree house detectives continue their search for the cause of the large drop in the local water table. They visit Indian Wells Elementary School in Indian Wells, Arizona to learn more about permeability and to find out how water travels through soil to become groundwater. R.J. decides to visit Dr. Hoke, a meteorologist with the National Oceanic and Atmospheric Administration (NOAA) to discuss how forecasters predict weather and rainfall. Meanwhile, the tree house detectives contact Corinne, a member of the NASA SCI Files™ Kids Club in Arizona, to meet with Dr. D at the Petrified Forest to learn more about climate. Dr. D explains that climate can change over time, and the detectives begin to wonder if an unusual climatic event is happening to cause a drought in their area.

## Objectives

Students will

- calculate the permeability rate of soils.
- make a model of a soil profile.
- understand how thunderstorms affect the water cycle.
- measure the amount of rainfall in an area.
- interpret weather maps.
- investigate folklore and customs related to rain.
- simulate how living things become petrified.
- explain the factors that are related to climate.

## Vocabulary

**climate** – the average weather conditions of a particular place or region over a period of years

**divining rod** – a forked rod believed to reveal the presence of water or minerals by dipping downward when held over a vein

**forecasting** – to calculate or predict weather conditions that are likely to happen in the days ahead by study and examination of data

**permeability** – the rate at which a liquid or gases are able to pass through materials such as soil

**petrify** – the process of turning something organic, or once living, into stone

**soil profile** – a vertical section of soil layers (horizons)

**topsoil** – the rich soil material found on the surface of the Earth

**weather** – the state of the atmosphere in regard to temperature, wind, pressure, precipitation, and humidity at a particular place and time

## Video Component

### Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

### Before Viewing

1. Prior to viewing Segment 2 of *The Case of the Wacky Water Cycle*, discuss the previous segment to review the problem and reaffirm what the tree house detectives have learned thus far. Download a copy of the Problem Board from the NASA SCI Files™ web site in the educator area under the “Tools” section. Have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 1 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have been dispelled during Segment 1. Use tools located on the Web, as was previously mentioned in Segment 1.

4. Focus Questions—Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes while viewing the program to help them answer the questions. An icon will appear when the answer is near.

5. What's Up? Questions—Questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. The questions can be printed from the web site ahead of time for students to copy into their science journals.

### View Segment 2 on the Video

For optimal educational benefit, view *The Case of the Wacky Water Cycle* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.



## After Viewing

1. Have students reflect on the "What's Up?" questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Have students work in small groups or as a class to discuss and list what new information they have learned about the water cycle, soil permeability, and how weather affects the water cycle.
4. Organize the information and determine if any of the students' questions from Segment 1 and 2 were answered.
5. Decide what additional information is needed for the tree house detectives to determine what may have caused a significant drop in the water level. Have students conduct independent research or provide students with information as needed. Visit the NASA SCI Files™ web site for an additional list of resources for both students and educators.
6. Choose activities from the educator guide and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.
7. For related activities from previous programs, go to the NASA SCI Files™ web site <http://scifiles.larc.nasa.gov> and download the Educator Guide for *The Case of the Phenomenal Weather*. Also visit the "Educator Area" of the web site and click on "Activities/Worksheets" in the menu bar at the top. Scroll down to "2001-2002 Season" and click on *The Case of the Phenomenal Weather*.
  - a. In the educator guide you will find
    - a. Segment 1—*Particular Particles and It's Time To Get Cirrus with Clouds*
    - b. Segment 2—*Vaporizing Vapor and Humble Humidity*
    - c. Segment 3—*The Probability Factor and Around and Around It Goes*
  - b. In the "Activities/ Worksheet" Section you will find
    1. *Storm Tracking Log*
    2. *Weather Status Report – Shuttle Launch*
8. If time did not permit you to begin the web activity at the conclusion of Segment 1, refer to number 6 under "After Viewing" (page 16 ) and begin the Problem-Based Learning activity on the NASA SCI Files™ web site. If the web activity was begun, monitor students as they research within their selected roles, review criteria as needed, and encourage the use of the following portions of the online, Problem-Based Learning activity:
  - **Research Rack**—books, internet sites, and research tools
  - **Problem-Solving Tools**—tools and strategies to help guide the problem-solving process
  - **Dr. D's Lab**—interactive activities and simulations
  - **Media Zone**—interviews with experts from this segment
  - **Expert's Corner**—listing of Ask-An-Expert sites and biographies of experts featured in the broadcast
9. Have students write in their journals what they have learned from this segment and from their own experimentation and research. If needed, give students specific questions to reflect upon as suggested on the *PBL Facilitator Prompting Questions* instructional tool found in the Educator Area of the web site.
10. Continue to assess the students' learning, as appropriate, by using their journal writings, problem logs, scientific investigation logs, and other tools that can be found on the web site. For more assessment ideas and tools, visit the Educator area and click on "Instructional Tools" in the menu bar.

### Careers

climatologist  
hydrometeorologist  
meteorological technician  
watershed manager

# Resources

## Books

Aardema, Verna: *Bringing Rain to the Kapiti Plain*. Penguin USA, 1983, ISBN: 014054612.

Barrett, Judith: *Cloudy with a Chance of Meatballs*. Simon and Schuster, 1982, ISBN: 0689707495.

Bird, E.J.: *The Blizzard of 1896*. Lerner Publishing Group, 1990, ISBN: 0876146515.

Diamond, Lynnell: *Let's Discover Petrified Forest National Park: A Children's Activity Book*. Mountaineers Books, 1991, ISBN: 0898862868.

Fleischman, Sid: *McBroom, the Rainmaker*. Penguin Putnam, 1999, ISBN: 084317496X.

Gibbons, Gail: *Weather Forecasting*. Simon and Schuster, 1993, ISBN: 0689716834.

Ketteman, Helen: *The Christmas Blizzard*. Scholastic, Inc., 1995, ISBN: 0590458787.

Ketteman, Helen: *Heat Wave*. Walker and Company, 2000, ISBN: 0802775772.

Peterson, David A.: *Petrified Forest National Park*. Scholastic Library, 1997, ISBN: 0516261118.

Tomecek, Steve: *Dirt*. National Geographic, 2002, ISBN: 0792282043.

Trueit, Trudi Strain: *Rain, Hail, and Snow*. Scholastic Library, 2002, ISBN: 053111970X.

White, Nancy: *Magic School Kicks up a Storm: A Book About Weather*. Scholastic, Inc., 2000, ISBN: 0439102758.

## Web Sites

### How Much Soil Is There?

Follow this interactive demonstration to learn how much soil can be found on the Earth. You may be surprised!

[http://ltpwww.gsfc.nasa.gov/globe/app\\_soil/hmsoil.htm](http://ltpwww.gsfc.nasa.gov/globe/app_soil/hmsoil.htm)

### What Is the Shape of a Raindrop?

Visit this web site to find out how raindrops are really shaped.

<http://www.ems.psu.edu/~fraser/Bad/BadRain.html>

### Petrified Forest National Park

A wonderful National Park Service site where you can learn about the history and geology of the Petrified Forest in Arizona and much more!

<http://www.petrified.forest.national-park.com/>

### What Is the Petrified Forest National Park?

Find out why the Petrified Forest of Arizona is so unique.

Learn about the geologic history and current events at the Park. View cartoon images to learn how wood became petrified.

<http://www.geo.arizona.edu/geos256/azgeology/pwood/parkintro.html>

### Interactive Weather Maps

On this web site, just type in your zip code to learn about the weather in your area. View weather maps in motion from the National Weather Service.

<http://www.weather.com>

### Info Please—Average Rainfall for US Cities

Find the average temperature and precipitation results for cities around the United States.

<http://www.infoplease.com/ipa/A0762183.html>

### State Soils

Learn about your state soil and its soil profile.

[http://soils.usda.gov/gallery/state\\_soils/](http://soils.usda.gov/gallery/state_soils/)

### All About Snow

Learn about snow facts, snow science, and snow blizzards in this web site sponsored by the Colorado Climate Center and NOAA.

<http://nsidc.org/snow/index.html>



## Activities and Worksheets

### **In the Guide**    **The Ability of Permeability**

Conduct a permeability experiment to learn how fast liquids pass through different types of soil. ....38

### **A Thunderstorming We Will Go!**

Simulate a thunderstorm by using visual imagery and calculate the amount of rain that “fell” during the storm. ....40

### **It’s Raining Rainsticks**

Learn about customs and folklore related to weather and make your own rainstick. ....42

### **Petrified Sponges**

Petrify a sponge to learn how petrified wood was formed. ....44

### **Sunny Ray**

Explore how the angle of the Sun’s rays affect climate. ....45

### **Just an Ocean Away**

Learn how large bodies of water affect climate. ....47

### **Answer Key**

.....49

### **On the Web**    **A Hole in One**

Calculate the permeability of the soil in your own backyard.

### **Gauging Rainfall**

Build your own rain gauge and compare your rainfall measurements to those recorded by the National Weather Service.

### **Stately Soils**

Learn about your state soil and compare its soil profile to other states’ soils.

# The Ability of Permeability

## Purpose

To investigate how quickly water moves through various materials

## Teacher Prep

For each group, prepare a 2-L bottle by using a marker to draw a cutting line around the middle of the bottle. With a sharp knife or scissors, cut the bottle at the cutting line.

## Teacher Note

If a beaker is not available, use measuring cups or create your own from paper cups

## Procedure

1. Place a piece of gauze over the spout of the bottle. (Cap should be removed.)
2. Use a rubber band to hold the gauze in place.
3. Measure 50 mL of water into a beaker and pour it into the bottom of the 2-L bottle.
4. On the outside of the bottle, use a marker to mark the level of water.
5. Empty the water out of the bottle.
6. Place the top of the bottle into the bottom. See diagram 1.
7. Observe the sand, gravel, and topsoil. Write your observations in your science journal.
8. Predict which material will allow water to pass through the quickest and which one will be the slowest. Record your predictions below.
9. Measure 350 mL of gravel and pour it into the top of the bottle.
10. Place a coffee filter on top of the gravel. See diagram 2.
11. Fill the beaker with 250 mL of water.
12. Set the stopwatch to begin timing when you start pouring the water into the bottle.
13. Quickly pour the water into the bottle, being careful not to splash the water out.
14. When the water level reaches the 50-mL mark, stop the stopwatch and record the time in the Data Chart (p. 39).
15. Empty the bottle of both water and gravel. Use a paper towel to clean the bottle for the next experiment.
16. Conduct two more trials for gravel by repeating steps 9–15.
17. Conduct three trials for sand by repeating steps 1 and 2 and steps 9–15.
18. Conduct three trials for topsoil by repeating steps 1 and 2 and steps 9–15.
19. Find the average time for each material and record.
20. Share your average times for each of the three materials with the class and create a class chart.
21. Find the class average time for each material.

## Materials

prepared 2-L bottle  
1050 mL of sand  
1050 mL of topsoil  
1050 mL of gravel  
3 pieces of gauze 5 cm x 5 cm  
2 rubber bands  
watch or stopwatch  
9 coffee filters  
beaker  
marker  
science journal  
paper towels

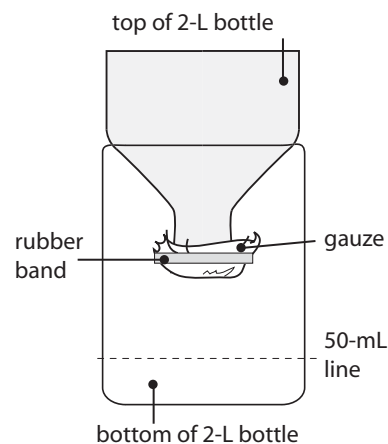


Diagram 1

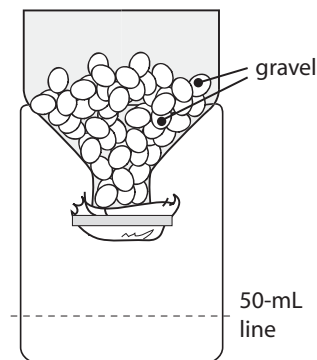


Diagram 2



## The Ability of Permeability (concluded)

**Predictions:** Quickest: \_\_\_\_\_ Slowest: \_\_\_\_\_

**Data Chart**

Material	Trial 1	Trial 2	Trial 3	Average
Gravel				
Sand				
Topsoil				

### Conclusion

1. Compare all three of your trials for gravel. Did you have about the same time for each trial? Why or why not? How about the sand? Topsoil?
2. Did other groups have similar times for each trial as your group did? Why or why not?
3. Which material allowed the water to pass through the quickest? Why?
4. Which material allowed the water to pass through the slowest? Why?
5. Did your predictions match your outcomes? Why or why not?
6. Which material is the most permeable?

# A Thunderstorming We Will Go!

## Problem

To simulate a thunderstorm through visual imagery and generate precipitation maps

## Background

Precipitation is monitored through a network of recording stations. A record of rainfall measurements helps watershed managers predict possible water shortages. If there is a chance the water table may be depleted, managers will need to implement water conservation strategies.

## Teacher Prep

1. Use masking tape to create a grid of 1-m squares. The grid should be large enough for each student to have a square.
2. Optional: This activity can be performed with the students standing in the square, but they can also sit in a chair within their square.
3. Have students cut apart the 1-cm square grid paper and place the squares of paper in a paper bag or basket. One sheet of 1-cm square paper for each student should be sufficient. Note: If 1-cm square paper is not available, have students make their own by using a metric ruler and notebook paper.
4. Discuss thunderstorms and create a list of the sights and sounds that are seen and heard during a storm.
5. Choose one student (rainmaker) to hold the bag of paper squares and stand in the center of the grid to disperse the rainfall (small squares of paper) on cue.
6. Explain that when you stand in front of or point to a row of students, they should imitate your motions continuously until told what the next motion is.
7. Start with a row on one end and begin with the first motion listed below.
8. Continue the motion as you stand in front of or point to each row down the line.
9. Return to the first group and start the second motion. This rhythmic motion will create a crescendo as the sounds being produced move from one end to the other.
10. Periodically, cue the rainmaker to make rain.

## Materials

masking tape  
20 sheets of 1-cm  
square grid paper  
scissors  
basket or paper bag  
meter stick  
science journal

## Motions

- Rub your hands together.
- Snap your fingers.
- Clap your hands together in an irregular cadence.
- Slap your hands on your legs.
- Optional: At this time, a student could flick a light switch on and off to simulate lightning while another student beats a drum to symbolize thunder.
- Stomp your feet.
- Slap your hands on your legs and stomp your feet (represents the height of the storm).
- Stomp your feet.
- Slap your hands on your legs.
- Clap your hands together in an irregular cadence.
- Snap your fingers.
- Rub your hands together.
- Open palms (quietly).



# A Thunderstorming We Will Go! (concluded)

## Student Procedure

1. Discuss thunderstorms and brainstorm a list of sights and sounds that are seen and heard during a thunderstorm.
2. Choose a square and stand in the center of it. This square represents one recording station.
3. As the group leader performs a motion in front of your row, copy that motion and continue the motion until given a new one.
4. If you are the rainmaker, you will need to stand in the center of the grid and be responsible for making it rain on cue by throwing a small handful of the squares of paper into the air.
5. When the storm has finished and everyone is quiet, collect all the rain squares inside your square of the grid. (This activity is not a contest to see who can collect the most. Rain will have fallen in different amounts in the different areas.)
6. Calculate the amount of precipitation for your station (square) by counting each piece of paper collected as a mm.
7. In your science journal, record the amount of precipitation in cm for your station. Remember that 10 mm make 1 cm.
8. Create a class chart of all monitoring stations and the amount of "rain" collected at each station.
9. In your science journal or in a class chart, draw a grid of the monitoring stations.
10. Record the precipitation calculated at each station.
11. Locate the station that received the most precipitation and mark it with a large "X".
12. Determine the areas that received about the same amounts of precipitation. For example, find every place that got between 2 and 2.5 cm of rainfall.
13. Draw a line to connect these stations of equal precipitation. They should form circles.
14. These circles are called isohyetal lines, and they indicate that every point along the line received the same amount of precipitation.

## Conclusions

1. What information can a meteorologist gain from looking at a map with isohyetal lines?
2. How might a hydrologist use the data from a weather map?
3. Why is it important to have local weather stations collecting weather data?
4. Why is NASA interested in studying thunderstorms?

## Extension

1. Convert the precipitation amounts on the map to snow depth: 2.5 cm of rain is equal to 25 cm of snow.
2. Create a wild and crazy weather report. For fun, give your report from the perspective of a trout, a tree, a fox, or a bird. What would they say about the storm? What would they tell their wild friends to do?
3. Practice presenting your weather report to an audience or videotape it.

# It's Raining Rainsticks

## Problem

- To learn about weather customs and folklore
- To make a rainstick

## Background

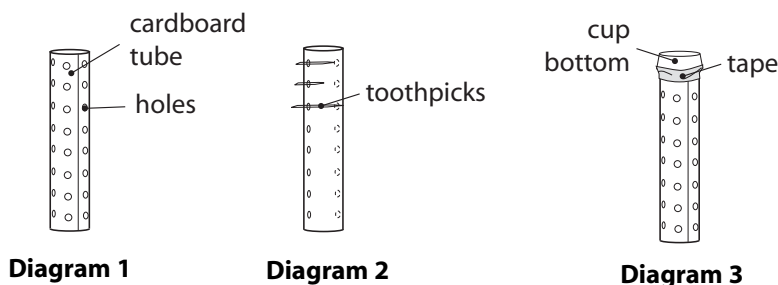
All cultures throughout history have been dependent on rain for an ample food supply. Without a sufficient amount of food, the culture would not survive. Rain was and is an important part of every culture, and droughts were and are serious business. Many cultures developed their own ways to welcome and celebrate the coming of rain, and since the earliest times various cultures have practiced an assortment of rainmaking rituals. The rainstick is one such ritual. Rainsticks were probably made originally from a naturally occurring plant that has internal fibers and mature seeds. When the ends were sealed off, the stick was tipped over so the seeds would bounce around inside, creating a sound like falling rain.

## Procedure

1. Use a pencil to mark dots 5 cm apart on all the sides of the cardboard tube.
2. With adult supervision, carefully use the sharp end of a compass to poke holes through the dots on the cardboard tube, being careful not to press too hard and cause the tube to collapse. See diagram 1.
3. Place the toothpicks in the holes so that a small piece of each end of a toothpick is sticking out. To create a variety of sounds, insert the toothpicks into the tube at different lengths. See diagram 2.
4. Place a small amount of glue around the toothpick where it sticks out of the tube.
5. Set aside and let the glue dry completely.
6. Once dried, carefully use fingernail clippers to clip off any toothpicks that stick out from the tube.
7. Tape one of the cup bottoms to one end of the rainstick tube. See diagram 3.
8. Turn the tube upside down and pour in the fill.
9. Tape the other cup bottom to the open end of the tube.
10. Carefully turn your rainstick over and over, listening to the sounds it creates.
11. To decorate the outside of your rainstick, cut paper the same length as your tube and wrap the paper around the tube and glue it in place. Add glue drops and roll in colored sand or add paint, feathers, or other decorations of your choice.
12. Individually or with a partner, use books and/or the Internet to conduct research to learn more about rain customs and rainmaking. Look for scientific projects as well as cultural traditions.
13. Create an oral or written report and present the information to your class.

## Materials

one cardboard tube  
two plastic cups with the bottoms cut out  
a selection of seeds, beads, or other small items (called fill)  
glue (wood glue works the best)  
tape measure  
pencil  
masking tape  
scissors  
nail clippers  
compass  
toothpicks  
paper  
markers, paint, feathers, yarn, or other items to decorate your rainstick



## It's Raining Rainsticks (concluded)

### Conclusion

1. Why are people so concerned about the weather?
2. What are some of the customs related to rain?
3. What are some things scientists today do to try to make it rain?
4. Do you think rainmaking really works? Why or why not?

### Extension

1. Use the resource list or ask your librarian to help you find a weather book. Create an oral or written report on weather instruments, forecasting, weather fronts, violent storms, rain-making, or any other information you find interesting.
2. Use books or the Internet to learn about popular weather sayings, such as, "rain before seven, clear by eleven," or "when dew is on the grass, no rain will come to pass," and discover the origins of the sayings. Survey parents and other adults to learn what weather sayings they have heard. Create a weather "saying" book and illustrate each saying.
3. Once a list of weather sayings has been created, survey students in other classes and/or adults to find out if they know the meaning of each.

# Petrified Sponges

## Problem

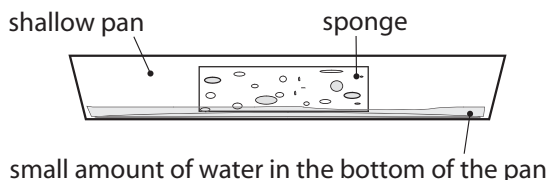
To simulate how living things may become petrified

## Background

Petrified fossils are made when water saturated with dissolved minerals seeps into the pore spaces found in once-living things. The water dissolves the bone, wood, or other remains and the minerals in the water crystallize, replacing the original material. The English word, petrify, actually means "to convert into rock or stone."

## Procedure

1. Set one sponge aside as a control to be used for comparison.
2. Put the warm water in the small bowl and slowly stir in Epsom salts until the solution becomes super saturated and no more salts will dissolve.
3. To make the solution easier to see, add a few drops of food coloring.
4. Pour the Epsom salts solution into a shallow pan.
5. Place the other sponge (test sponge) into the pan and watch the water absorb and travel up through the holes in the sponge.
6. Set the pan with the sponge in a warm, dry place where it will not be disturbed for several days.
7. When the sponge is completely dry, feel it and compare it to the control sponge.
8. Carefully observe inside the holes. Use a magnifying glass to observe more closely. Record and illustrate your observations.



## Materials

two sponges with large, visible holes  
a shallow pan  
small bowl  
200 mL Epsom salts  
200 mL warm water  
food coloring  
magnifying glass (optional)

## Conclusion

1. Explain what happened to the sponge that was put into the Epsom salts solution?
2. Explain how the sponge is similar to the trees in the Arizona Petrified Forest?

## Extension

1. Use books and other resources to learn more about the Petrified Forest National Park in Arizona.
2. Learn about geologic time and create a geologic time line illustrating the way the Petrified Forest National Park may have looked through each time period, starting with the Triassic Period.
3. The petrified trees of the Petrified Forest National Park were conifers or cone-bearing trees. What kinds of conifers exist today? Make a list of the conifers in your area.
4. Like human beings, trees can become unhealthy and die. Observe nearby trees and note such things as broken branches, holes, unusual leaf color or shape, splits in the wood, or scars. Sketch the tree in your science journal. Develop a hypothesis about what might have happened to each tree. Write a story about the event and share your story with the class.

# Sunny Ray

## Purpose

To explore how the angle of the Sun's rays affects climate

## Background

The amount of energy coming from the Sun is nearly constant. However, because the Earth is shaped like a sphere, the Sun's rays strike the Earth's surface at different angles, creating variances in temperatures on Earth. The equator receives the most direct sunlight because the same number of sunlight rays are concentrated in smaller areas of direct exposure, causing warmer temperatures and climates. Latitudes near the poles always receive the Sun's rays at low angles, thus creating a cold climate. In the middle latitudes, like the United States, the angle of the Sun's rays varies from low in the winter to higher in the summer, causing seasonal temperature changes. Hawaii is the only state in the United States where the Sun's rays are directly overhead.

## Materials

flashlight  
construction paper  
graph paper  
tape  
colored pencils  
metric ruler (optional)  
science journal

## Procedure

1. Roll a piece of construction paper into a tube that is slightly larger than the glass of the flashlight. Use tape to hold the roll in place.
2. Using tape, attach the paper tube to the outer edge of the flashlight glass. See diagram 1.
3. Place a sheet of graph paper, which represents the Earth's surface, on a table or flat surface.
4. Point the flashlight and tube, which represent a ray from the Sun, straight down at a 90° angle about 15 cm above the paper. See diagram 2.
5. Draw a line around the outer edge of the lighted area on the paper.
6. Count and record in your science journal the number of lighted squares. Note: If half or more of a square is lighted, count it as one.
7. Repeat step 4, holding the flashlight at a 45° angle to the paper. Make sure that the height of the flashlight and tube remains 15 cm above the paper. See diagram 3.
8. Using a different color pencil, repeat steps 5–6.
9. Compare and discuss the results.
10. Write one paragraph explaining why there were more or fewer squares when the light was at a 45° angle.

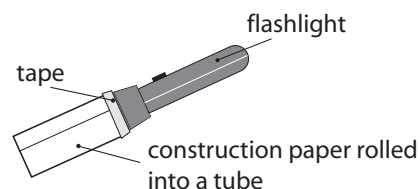


Diagram 1

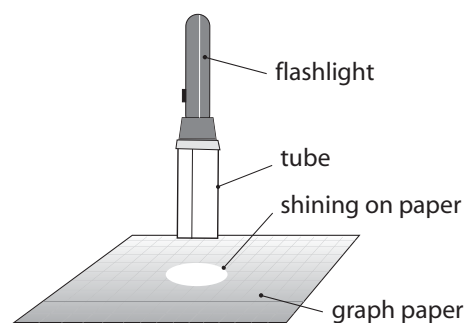


Diagram 2

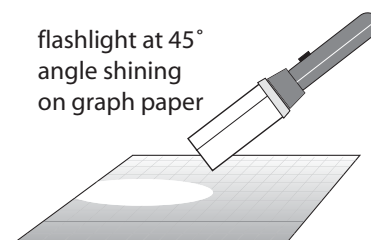


Diagram 3

## Sunny Ray (concluded)

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### Conclusions

1. At what angle did you get the smallest area of light?
2. If you were able to measure the temperature of the two areas, which one do you think would be hotter?
3. The tree house detectives learned that an area's climate is determined by an area's weather over a long period of time. If the angle of the Sun can affect the temperature of an area on Earth, how can it affect climate?

### Extension

1. Using a globe and the Internet, look up the temperatures of cities around the world on any given day. Compare them to the temperature of your city. Mark the locations of the cities on a world map. What relationship, if any, is there between the temperatures of the cities and their latitudes? What other factors might influence temperature?
2. Read a book about climate or weather. Choose a book on weather or climate from the resource list or ask your librarian for assistance. Give an oral or written report about what you learned.



# Just an Ocean Away

## Problem

To explore how large bodies of water affect climate

## Background

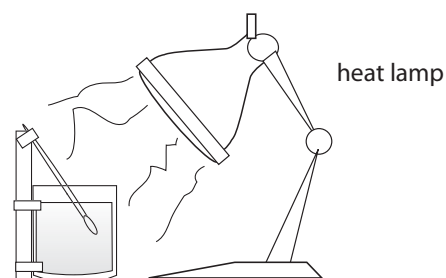
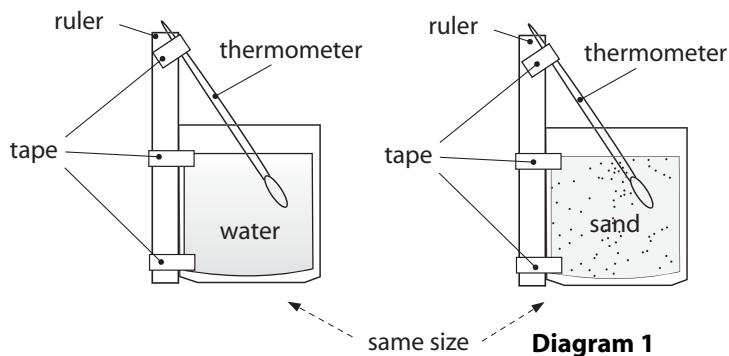
Large bodies of water, such as oceans or very large lakes, such as the Great Lakes have a great affect on climate. Oceans warm and cool slowly; therefore, ocean temperatures in a region usually do not vary much throughout the year. Land, on the other hand, heats and cools quickly, and temperatures can vary greatly even between day and night.

## Procedure

1. Fill one container with room temperature water (about 20° C) until the water is 3 cm from the top rim.
2. Fill the other container with sand or soil 3 cm from the top rim.
3. Tape a ruler to the outside of each container.
4. Insert a thermometer in each container so that the bulb is 1 cm below the surface of the water and sand.
5. To keep the thermometers secure, tape each one to the ruler on its corresponding can. See diagram 1.
6. Read and record the temperature of both the water and the sand.
7. Place a heat lamp 30 cm from the containers so that the light from the lamp will shine directly on them. See diagram 2.
8. Turn the lamp on.
9. After 1 minute, read and record the temperature in each container.
10. Repeat step 9 at 3- and 5-minute intervals.
11. After the last reading, turn off the lamp.
12. Wait 4 minutes.
13. Read and record the temperatures of the sand and water.
14. Create a line graph to show your results.

## Materials

2 small, same size containers  
sand or soil  
water  
lamp (heat lamp works best)  
stopwatch or clock  
2 metric rulers  
2 thermometers  
tape



## Just an Ocean Away (concluded)

Substance	Starting Temp.	Lamp On 1 minute	Lamp On 3 minutes	Lamp On 5 minutes	Lamp Off Wait 4 minutes
Sand					
Water					

Draw graph below

### Conclusion

1. When the light was turned on, which substance, sand or water, had the quickest change in temperature?
2. When the light was turned off, which substance had the slowest change in temperature?
3. After completing this experiment, what generalizations can you make about how land and water heat and cool?
4. How would the ability of water and land to heat and cool affect the temperature of nearby land areas?
5. The tree house detectives live in Virginia. What land or water features might affect the temperature in their area?
6. Are there any land or water features that might affect the temperature where you live? Explain why or why not?

### Extension

1. Climate is influenced by three main factors: latitude, land or water mass, and surface differences, such as mountains or valleys. Using clay or papier mâché, make a 3-D topographical map of your area. Examples of topographic maps may be found at <http://mcmweb.er.usgs.gov/topomaps/>. On your map, be sure to include any large bodies of water and determine the latitude of your city. In your science journal, discuss how these factors affect the climate in your area.
2. Find at least three other cities in the world that have similar latitudes as your city. Using the Internet or a newspaper, record, for one month, the daily temperatures of your city and each of the cities you chose. To record your findings in your science journal, create a chart. Graph your data. To compare each city's temperature, graph and analyze the data. In your group or class, discuss your findings and offer any explanation for what you found.



# Answer Key

## The Ability of Permeability

1. Answers will vary, but similar times should have been received for each gravel trial. The gravel in each trial is basically the same consistency and the time it took water to pass through it should not vary too much. Same for the sand and topsoil.
2. Other groups should have had similar times because they too were using the same gravel, sand, and topsoil mixture.
3. In most instances, the gravel allows the water to pass through the quickest because it has larger pore spaces between pieces of gravel.
4. This answer will vary, depending on the type of soil and topsoil used for your area.
5. Answers will vary.
6. The gravel is the most permeable.

## The Incredible Edible Soil Profile

1. The parent material determines the texture of a soil. As the soil breaks down, the amount of weathering also plays a role, but the type of rock from which the material is weathered determines whether it will be clay, sand, silt, or loam.
2. As the subsoil is exposed to weather, such as freeze-thaw cycles, rain, and wind, the pieces are broken down even further into smaller and finer particles. It is at this stage that horizons, or visible layers form. Topsoil, the uppermost layer, is formed as the soil continues to break down.
3. Besides being indicators of a healthy soil, earthworms and other organisms are important decomposers. They break up the dead plant material that is left in the soil, forming dark, rich topsoil. Some organisms take nitrogen from the air and make it available to plants for growth.
4. Because soil holds and absorbs water, provides nutrients for plants which use and store water, and helps regulate surface temperature, it plays an important role in the water cycle.

## A Thunderstorming We Will Go!

1. Isohyetal lines indicate patterns of precipitation that fall in nearly the same amounts over different areas.
2. A hydrologist will use this information to help determine water use regulations, predict crop success, and investigate groundwater recharge.
3. It is important to have local weather stations record rainfall and temperature because these weather phenomena can change very quickly in nearby geographic areas. People have reported seeing it rain in the front yard but not in the back yard. The more

weather information you collect, the more precise the weather data you record, the more accurate is the forecast.

4. Although thunderstorms play a critical role in the water cycle, they can also cause problems for aircraft. NASA is studying thunderstorms to help make air travel safer.

## It's Raining Rainsticks

1. Weather affects both work and recreation in our lives every day. It influences what we eat, how we dress, what types of transportation we use, how we will work or play that day, and even the type of home in which we live. Predicting weather can make our lives more comfortable and safer.
2. Answers will vary.
3. Answers will vary, but students should have discovered information on cloud seeding.
4. Answers will vary.

## Petrified Sponges

1. The sponge in the Epsom salts solution hardened like stone.
2. The sponge absorbed the mineral saturated solution. As the water in the solution began to evaporate, the salts that were left behind began to crystallize. They hardened and the sponge, like the wood, became petrified, or turned to stone. In the petrified wood, however, the mineral crystals replace the original material as it rots away.

## Sunny Ray

1. The smallest area of light is recorded when the flashlight is held directly over the paper at a 90° angle.
2. Because the energy from the Sun remains constant, the temperature in the larger area would be lower than that in the smaller area because the Sun's rays must be distributed over a larger area.
3. The lower the angle of the Sun's rays, the more area is exposed to those rays. The temperature would therefore be cooler. Consider how the evening temperatures cool off when the Sun's rays are no longer directly overhead. The temperature of an area is affected by the Sun's angle and the temperature of an area is one factor that determines an area's climate. So the climate of a region is dependent on the angle of the Sun.

## Answer Key (concluded)

### Just an Ocean Away

1. The container of sand had the fastest change in temperature.
2. The container of water had the slowest change in temperature.
3. Answers will vary but should include that land areas cool and heat more quickly than water areas.
4. Large bodies of water such as oceans help to create a more consistent temperature on nearby land. During the day in the summer, the water helps to make the land temperature cooler, while at night it helps to make it warmer. The differences in the temperatures between land and water also create land and sea breezes.
5. The Virginia shoreline is approximately 5,000 miles long and includes the four tidal rivers of Virginia (the Potomac, the Rappahannock, the York, and the James), the Chesapeake Bay, into which they drain, and the Atlantic Ocean.
6. Answers will vary.

### On the Web

#### A Hole in One

1. Once water has filled the air spaces between the soil particles the first time, the saturated soil allows water to flow through the soil more quickly. One of the physical properties of water is its ability to adhere to other materials. As water moves down through the soil, it adheres to soil particles and fills the spaces between the materials. Some of the water is trapped, so new water has fewer spaces to fill, allowing it to flow downward at a faster rate.
2. Perc tests determine how water will flow from household or industrial waste or where drainage/sewer systems should be placed.
3. The tree house detectives needed to understand how fast water moves through the soil so they could determine how groundwater supplies are recharged.

### Gauging Rainfall

1. The amount of rainfall is one of the climate predictors for an area. Meteorologists use this information to help them determine what kinds of weather to expect in the future, to find weather patterns, and to make predictions about the effect of such weather on human populations.
2. The rainfall for a specific time period (e.g., monthly) is recorded for several years. The amounts are then averaged (the totals added and divided by the number of rainfalls) to find the average precipitation for that particular time period. Data may be collected for 20–30 years to determine weather averages.

### Stately Soils

1. Answers will vary, but appropriate responses should be found on the web site.
2. Answers will vary.

